

Binary magic trick

by Theoni Pappas

- 1) Ask a student to select a number from 1 up to but not including 32.
- 2) Ask a student to tell you on which cards the selected number appears. With this information you can tell the student which number is his/her choice.

- This is a great way to introduce number systems, especially base two.

Introduce binary number system.

32's place	16's place	8's place	4's place	2's place	1's place
2^5	2^4	2^3	2^2	2^1	2^0

Every number has a unique binary number, e.g. 7 in base ten converts to 111 in base two. $1(4) + 1(2) + 1(1) = 7$.

Some special properties of binary numbers:

- every even number ends in 0, so card A has no even numbers on it.
- every odd number ends in 1, so card A, must have all the odd numbers on it.

How the trick works.

Each number chosen must either appears or not appear on cards A through E. Each card represents a placevalue of the binary number system.

If I am told, it is on cards E, D, B, and A. I write

E D C B A
1 1 0 1 1

In base two, this number is written as 11011—> which when converted to base ten becomes 27 because $16+8+0+2+1 = 27_{\text{ten}}$
 $1 \quad 1 \quad 0 \quad 1 \quad 1_{\text{two}}$

You can make more cards which will extend how many numbers are available to choose from. For example, if you add the next card F (which will start with the number 32 in the left hand corner), you will now be able to write the numbers up to 63. BUT, you'll have to add new numbers on your old cards, For example, the number 50 when written in base two is 110010, which means 50 appears on cards E, D, and B.